Method and communications arrangement for matching transmission resources between a central and a number of decentralized communications devices

CLAIM OF PRIORITY

This application claims priority to International Application No. PCT/DE00/02132 which was published in the German language on January 11, 2001, and which claims benefit of priority to German Application No. 199 30 228.6, filed in the German language on June 30, 1999, the contents of which are hereby incorporated by reference.

TECHNICAL FIELD OF THE INVENTION

This application relates to systems and methods for matching resources between a central communication system network and a number of decentralized communication devices.

BACKGROUND OF THE INVENTION

In present-day communications networks based on the Asynchronous Transfer Mode - ATM - a number of decentralized communications devices, or a number of communication terminals which are each connected to the decentralized communications devices, are connected via a subscriber access network to a higher-level ATM communications network. The subscriber access network may, for example, be configured, on the basis of a point-to-multipoint configuration as a passive optical network - also referred to as PON - by means of glass fibers. No active optical or electrical components - such as amplifiers or multiplexers - are required to produce a passive optical network, and no power supply

is required within these networks, either. A central point can access the subscribers connected to it by means of passive optical splitters - which are also referred to as combiners. Special active devices for termination of the optical transmission path are arranged at each of the end points of the glass fibers, with an optical line termination "OLT" - also referred to as an optical network monitoring unit in the following text - generally being provided at the central point, and further optical network units "ONU" - also referred to as optical network termination units in the following text - generally being provided at the decentralized point. The information is transmitted via the passive optical network either in separate directions by means of two glass fibers, or else via a single glass fiber using a wavelength-division multiplex method.

Passive optical networks are known to those skilled in the art from the ITU Specification ITU-T G.983.
The access by the network termination units, and by the communications terminals which are connected to the network termination units, via the jointly used transmission medium to the higher-level ATM communications network is controlled by an access algorithm, which is normally in the form of hardware when the transmission speeds are high and when a large number of communications terminals are connected. The access algorithm is used to grant access authorization and access to the jointly used transmission medium to a network termination unit requesting communications network resources. Instead of communications units, lower-level communications networks - for example local area networks or LANs - can also be connected to the higher-level ATM communications network via the jointly used communications network.

The document "NOVEL ALGORITHM FOR TIME DIVISION

MULTIPLE ACCESS IN BROADBAND ISDN PASSIVE OPTICAL NETWORKS, International Journal of Digital and Analog Communication Systems, VOL. 6, pages 55 to 62 (1993), M. Glade and H. Keller", for example, describes a method for controlling access by network termination units to predetermined resources in a subscriber access network in the form of a passive optical communications network. According to the disclosed method, a timer or counter is provided for each network termination unit, in a network monitoring unit which is arranged centrally in the subscriber access network and is connected to each network termination unit, and the timers or counters are started during the processes for setting up connections derived from the network termination units. A timer times out, or the counter reaches a predetermined value, as soon as a new data packet or a specially reserved memory area is filled with user data in a relevant network termination unit, and is temporarily stored, for data transmission, in a buffer store which is likewise located in the network termination unit. The design of the counters which are arranged in the network monitoring unit, or the definition of the time at which a timer times out is dependent on the respective data transmission rates defined or reserved in each case while setting up connections. A signalling signal which indicates that a timer has timed out represents a network termination unit-specific request for transmission authorization or access to the jointly used transmission medium, which is stored sequentially in a memory - for example a FIFO memory - which is used jointly by all the network termination units connected to the network monitoring unit and is located in the network monitoring unit. The stored access requests are read from this memory and are transmitted as an actual transmission authorization to the connected network termination units or communications terminals, as a result of which access is granted to the jointly used transmission medium. In

the described method, for example, two timers may time out at the same time, that is to say two simultaneous access requests may need to be stored and controlled. However, since two simultaneous accesses are impossible, one of the two access requests is delayed until the actual access by the other access request has been completed. This delay is referred to as the "cell delay variation". If a number of timers time out at the same time, the value of the "cell delay variation" is increased appropriately.

In the communications technology based on the Asynchronous Transfer Mode, a number of ATM traffic types - also referred to as ATM service classes or available services - are known, which have been defined by the ATM forum and by means of which data links and high-bit-rate data transmission with different requirements, for example, for the transmission bandwidth and delay times are supported and/or provided. Voice, images and data, for example, can be transmitted in ATM communications networks, using ATM connections, which each have a guaranteed transmission quality and/or transmission characteristics, via the same subscriber connections using a type of cell multiplexing method. The following ATM traffic types - also referred to as ATM service classes in the following text - which have been defined by the ATM forum should be mentioned, by way of example:

- "Constant Bit Rate" (CBR),
- "Variable Bit Rate - real time" (VBRrt),
- "Variable Bit Rate - non real time" (VBRnrt),
- "Guaranteed Frame Rate" (GFR),
- "Unspecified Bit Rate" (UBR), and
- "Available Bit Rate" (ABR).

When setting up an ATM link, the respective ATM traffic parameters which represent the quality and/or the

transmission characteristics of the ATM links, and the quality of service - also referred to as the quality of service parameter or QoS parameter - are negotiated in the course of a CAC - Connection Admission Control - process for the desired ATM traffic types, and are defined in what is referred to as a traffic contract. Examples of ATM traffic parameters include "Peak Cell Rate, PCR", "Sustainable Cell Rate, SCR" and "Minimum Cell Rate, MCR". Examples of QoS parameters include "Cell Delay Variation, CDV", "Cell Transfer Delay, CTV", and "Cell Loss Ratio, CLR".

The ATM service classes CBR and VBR are particularly suitable for applications with stringent QoS requirements, such as multimedia services or videoconference circuits with high-quality video transmission. Constant Bit Rate CBR allows data transmission at a constant transmission speed, and constant, very short delay times, with the required bandwidth being characterized by quoting a peak cell rate PCR which must be provided throughout the entire duration of the connection.

When setting up ATM connections in the ATM service class VBR, peak and minimum transmission rates are negotiated between the ATM communications network and the respective communications terminal. In this category, a distinction is drawn between real time "VBRrt) and non-real-time requirements (VBRnrt). The ATM service class VBRrt places similarly stringent requirements on the cell delay and the variation in the cell delays as the ATM service class CBR, while only a certain upper limit need by complied with for the ATM service class VBRnrt.

In the case of connections which are based on the ATM service class ABR, although a minimum transmission speed is agreed, the best-possible transmission speed

is, however, always used, if possible.

The ATM service class UBR represents a quality of service in which, in contrast to CBR and VBR, no fixed bandwidth is reserved, and no cell loss rate CLR is defined, either. When a UBR connection is to be set up or is desired, no demands whatsoever are placed on the connection and, hence, no transmission quality whatsoever is guaranteed by the communications network.

The ITU-T Specification I.356 "B-ISDN ATM Layer Cell Transfer Performance" describes the breakdown of the QOS classes defined by the ATM forum into a stringent class (Class 1) and into non-stringent classes (Class 2, Class 3, U Class).

SUMMARY OF THE INVENTIION

The invention is based on the object of achieving effective utilization of the transmission resources provided by the transmission medium when a number of connections, in particular ATM connections, are routed via a jointly used transmission medium - for example a passive optical network (PON).

One embodiment is a method according to the invention for matching transmission resources between a central and a number of decentralized communications devices, the central communications device allocates to each of the decentralized communications devices a transmission resource element as a function of the quality and/or the transmission characteristics of at least one connection which is routed via the respective transmission resource element. The major aspect of the method according to the invention is that the transmission resource elements which are allocated to the decentralized communications devices are at least partially reduced, and the quality and/or transmission

characteristics of the at least one connection which is routed via the respective reduced transmission resource element is determined. The extent of the reduced transmission resource element which is allocated to each decentralized communications device is modified or retained as a function of the quality and/or the transmission characteristics.

An advantage of this method is that flexible matching of the transmission resources provided by a jointly used transmission medium makes it possible to increase the traffic throughput via the transmission medium and to effectively utilize the transmission resources of the jointly used transmission medium. The at least temporary allocation of transmission capacities in the transmission medium which are reserved but are not currently used results in an improved "burst response" in, for example, "passive optical networks".

The transmission resources which become free as a result of at least partial reduction of the allocated transmission resource elements advantageously result in other decentralized communications devices being made available, at least temporarily. The effective utilization, obtained in this way, of the transmission resources provided by the transmission medium makes it possible to increase the number of subscribers connected to the transmission medium, and/or the number of connections routed via the transmission medium, while retaining the transmission quality for all the connections.

According to another embodiment, the at least one connection which is routed via the respective allocated transmission resource element is implemented using Asynchronous Transfer Mode ATM, with the ATM connection being configured in accordance with a standardized ATM service class, which in each case specifies the quality

and the transmission characteristics of the ATM connection, the information to be transmitted using an ATM connection is stored in at least one queue in each decentralized communications device. The current queue filling level of the at least one queue is recorded and subsequently, by assessing the recording result, the quality and the transmission characteristics of the respective ATM connections are determined, and the allocated transmission resource element is modified as a function of the quality and of the transmission characteristics. The use of the method according to the invention for ATM connections using the Asynchronous Transfer Mode advantageously makes it possible for the queues or ATM cell buffers arranged in the decentralized communications devices to be designed to be less extensive, while also reducing the delay times for ATM cells passing through the decentralized communications devices. The use of the respective queue filling levels for assessing the quality and the transmission characteristics of the respective ATM connections makes it possible for the method according to the invention, in particular when using the communications networks based on the Asynchronous Transfer Mode ATM, to be designed to be particularly simple and hence economic.

Advantageously, when a number of ATM connections are routed via one decentralized communications device, the queue filling levels of the queues are recorded and assessed as a function of the ATM service class of the respective ATM connections. An ATM service class specific sum of the queue filling levels of the corresponding queues is formed for each ATM service class, with the ATM service class specific queue total filling level information which is formed being weighted as a function of the ATM service classes. The assessment of the weighted, ATM service class specific queue total filling level information makes it possible

to determine the quality and the transmission characteristics of the ATM connections in an ATM service class on an ATM service class specific basis in each case, and to modify the transmission resource element, which is allocated to the decentralized communications device, as a function of the quality and the transmission characteristics. This advantageous ATM service class specific assessment of the quality and transmission characteristics of ATM connections in an ATM service class makes it possible to allocate the transmission resource elements of a jointly used transmission medium optimally and, in particular in the case of communications networks based on the asynchronous transfer mode ATM, to achieve optimum, that is to say effective, use of the "upstream PON transport quality", taking account of compliance with the ATM quality features.

BRIEF DESCRIPTION OF THE DRAWINGS

The method according to the invention will be explained in more detail in the following text with reference to two drawings, in which:

Figure 1 shows a large number of communications terminals which are connected to a higher-level communications network via a jointly used transmission medium in the form of a "passive optical network".

Figure 2 shows an example of a scenario of ATM connections which are currently routed via an optical network termination unit which is connected to the "passive optical network", and correspondingly arranged connection specific queues.

DETAILED DESCRIPTION

Figure 1 shows, in the form of a block diagram, a subscriber access network ACCESS via which a large number of communications terminals KE1…z, which are each allocated a subscriber, are connected to a higher-level communications network OKN. In this exemplary embodiment, the subscriber access network ACCESS is in the form of a passive optical network PON in a point-to-multipoint configuration. The central component of the passive optical network PON is an optical network monitoring unit OLT which, for example, is connected via an optical waveguide LWL to predetermined transmission resources vr in the higher-level communications network OKN. The higher-level communications network OKN is designed using the asynchronous transfer mode ATM, with the predetermined resources vr in the higher-level ATM communications network OKN having a data transmission rate of, for example, 155 Mbit/s. The optical network monitoring unit OLT is connected via a number of glass fibers and via a passive optical splitter - which is also referred to as a combiner - to three optical network termination units ONU1…3, with the jointly used "passive optical network" PON transmission medium being terminated by the three optical network termination units ONU1…3 and by the optical network monitoring unit OLT.

The three optical network termination units ONU1…3 are connected to a total of z communications terminals KE1…z, in which case each communications terminal KE1…z can access the predetermined resources vr in the ATM communications network OKN. The request for resources can, for example, be produced administratively as part of the network management function or by means of package-oriented transmission protocols - for example, TCP/IP - by transmitting an appropriate connection

set-up message from a communications device KE1…z to the corresponding optical network termination unit ONU1…3. The respective optical network termination unit ONU1…3 then initiates the process of setting up a connection in an appropriate manner and in accordance with the protocol to the optical network monitoring unit OLT, and from there to the higher-level ATM-oriented communications network "OKN". In the course of setting up a connection, corresponding, ATM connections are then allocated to the respective optical network termination unit ONU1…3 and to the respective communications terminal KE1…z.

The ATM forum has defined various ATM service classes, with each ATM connection associated with an ATM service class being specified by its specific ATM traffic parameters and QoS parameters. For example, ATM connections in the "Constant Bit Rate, CBR" service class and in the "Variable Bit Rate - real time, VBRrt" service class, have a specific "Peak Cell Rate, PCR" as the guaranteed data transmission rate - also referred to as the "guaranteed minimum transmission capacity". ATM connections in the "Variable Bit Rate - non real time, VBRnrt" ATM service class have a specific "Sustainable Cell Rate, SCR", and ATM connections in the "Guaranteed Frame Rate, GFR" ATM service class and in the "Available Bit Rate, ABR" ATM service class have a specific "Minimum Cell Rate, MCR" as the guaranteed data transmission rate.

The optical network monitoring unit OLT controls the access by the individual optical network termination units ONU1…3 to the jointly used "Passive Optical Network" PON transmission medium as a function of the ATM connections which are allocated to each optical network termination unit ONU1…3, or as a function of the respective ATM service class of the associated ATM connections. To this end, the optical network

monitoring unit OLT contains an access control unit MAC which is used to define, at the ATM-MAC layer - Medium Access Control - level, and on the basis of the various ATM traffic parameters and QoS parameters which specify the individual ATM connections, what the optimum sequence is for the three optical network termination units ONU1...3 to access the jointly used "Passive Optical Network" PON transmission medium for information transmission in the upstream direction.

The transmission of access information - also referred to as "grants" -, which controls the access to the jointly used "Passive Optical Network" PON transmission medium, from the optical network monitoring unit OLT to the connected optical network termination units ONU1...3 is described in more detail in the ITU-T Specification G.983. This will not be described in any more detail.

For this exemplary embodiment, it is assumed that the jointly used "Passive Optical Network" PON transmission medium has specific transmission resources rpon, which are oriented for time division multiplexing, and that the three optical network termination units ONU1...3 are each allocated with transmission resource elements from the time-division-multiplex-oriented transmission resources rpon, as a result of which the three optical network termination units ONU1...3 are allocated access to the "Passive Optical Network" PON using a TDMA access method. It is also assumed that a different number of ATM connections are routed through the "Passive Optical Network" PON via the three optical network termination units ONU1...3.

First time-division-multiplex-oriented resource elements tpr1 in the passive optical network PON are allocated to the first optical network termination unit ONU1 and second time-division-multiplex-oriented resource elements tpr2 are allocated to the second

optical network termination unit ONU2, and third time-division-multiplex-oriented resource elements tpr3 are allocated to the third optical network termination unit ONU3, for transmission of information in the upstream direction, as a function of the ATM traffic parameters and the QoS parameters of the respectively associated ATM connections - controlled by the optical network monitoring unit OLT. The assignment of time-division-multiplex-oriented resource elements tpr1…3 by the optical network monitoring unit OLT is also referred to as "grant generation".

The control, according to the invention, of the access by the optical network termination units to the jointly used transmission medium PON will be explained in more detail in the following text. To this end, by way of example, Figure 2 shows the actual connection situation at a specific time for ATM connections which are routed via one of the optical network termination units ONU1…3 which are illustrated in Figure 1, to the higher-level ATM communications network OKN. As shown in Figure 2, three ATM connections vCBR1…3 in the stringent class CBR are routed via the illustrated optical network termination unit ONU1…3, in accordance with the ITU-T Specification I.356. Furthermore, an ATM connection vVBRrt in the ATM service class VBRrt, x ATM connections vVBRnrt1…x in the ATM service class VBRnrt, y ATM connections vGFR1…y in the ATM service class GFR and one ATM connection in the ATM service class vUBR are routed via the optical network termination ~~unit~~units ONU1…3.

The information or ATM cells which are transmitted by those communications terminals KE1…n, KEn+1…m, KEm+1…z which are connected to the optical network termination unit ONU1…3 in the upstream direction using the three stringent ATM connections vCBR1…3 are temporarily stored in a first queue WS1, which is used jointly by

the ATM connections in the ATM service class CBR, with the respectively temporarily stored ATM cells being read from the first queue WS1 in accordance with the FIFO principle. The ATM cells which are transmitted via the ATM connection vVBRrt are temporarily stored in a second queue WS2. Furthermore, the ATM cells in the x ATM connections vVBRnrt1…x in the ATM service class VBRnrt are in each case temporarily stored in a third to k-th queue WS3…k, and the ATM cells in the y ATM connections vGFR1…y in the ATM service class GFR are in each case temporarily stored in an l-th to m-th queue WSl…m. ATM cells for the ATM connection vUBR in the ATM service class UBR are temporarily stored in an n-th queue WSn. In contrast to ATM connections in the ATM service class CBR, a connection-specific queue WS2…n is provided in the optical network termination unit ONU1…3 for each ATM connection in the tolerant ATM service classes, that is to say for ATM connections in the ATM service classes VBRrt, VBRnrt, UBR, GFR.

The queues for ATM connections in a tolerant ATM service class VBRrt, VBRnrt, UBR, GFR are read using the weighted fair queuing algorithm - also referred to as a WFQ scheduler. In the WFQ scheduler, the respective queues WS2…n are read in a weighted manner as a function of the ATM service class VBRrt, VBRnrt, UBR, GFR for the respective ATM connection. The weighting factor for the respective queues WS1…n which are arranged in an optical network termination unit ONU1…3 can be configured as required, with the weighting factors being derived by a control unit STG, which is arranged in the optical network termination units ONU1…3, as a function of the ATM traffic parameters - PCR, SCR, MCR - and the QoS parameters - CDV, CTD, CLR - of the respective ATM connections vCBR1…3, vVBRrt, vVBRnrt1…x, vGFR1…y, vUBR which are routed via the optical network termination unit ONU1…3 at that time. The WFQ scheduler is subordinate to an

absolute delay priority algorithm - also referred to as an ADP scheduler -, by means of which the queue of ATM connections in the stringent class - in this case WS1 - is read with priority.

The transmission resource elements tpr1...3 which are allocated to an optical network termination unit ONU1...3 in the passive optical network PON, as well as the weighting factors for the queues WS1...n which are arranged in the optical network termination units ONU1...3 are configured in the normal way such that all the guaranteed transmission capacities are complied with for those ATM connections vCBR1...3, vVBRrt, vVBRnrt1...x, vGFR1...y, vUBR which are routed via the respective optical network termination unit ONU1...3. According to the invention, the transmission resource elements tpr1...3 which are respectively allocated to the individual optical network termination units ONU1...3 are reduced, on an ATM service class specific basis, by the access control unit MAC which is arranged in the optical network monitoring unit OLT, such that only a portion of the sum of the guaranteed minimum transmission resources of the ATM connections vCBR1...3, vVBRrt, vVBRnrt1...x, vGFR1...y, vUBR which are routed via the respective optical network termination units ONU1...3 is still covered by the resource elements tpr1...3 which are allocated to the individual optical network termination units ONU1...3, and which are now reduced. In this way, the transmission resource which has in consequence become free in the upstream direction in the passive optical network PON can be used flexibly by other optical network termination units ONU1...3 for transmitting ATM cell bursts.

According to the invention, in order to provide central monitoring for the ATM traffic parameters and the QoS parameters of the respective ATM connections vCBR1...3, vVBRrt, vVBRnrt1...x, vGFR1...y, vUBR which are routed via

an optical network termination unit ONU1…3, the current filling levels fs1…n of the queues WS1…n which are arranged in each optical network termination unit ONU1…3 - and which are also referred to as "ONU output queues" - are transmitted to the optical network monitoring unit OLT. The checking of the current queue filling levels fs1…n of the queues WS1…n pointing in the upstream direction in an optical network termination unit ONU1…3 is carried out on a fixed time pattern by the optical network monitoring unit OLT. In this case, the transmission of the current queue filling levels fs1…n of all the connected optical network termination units ONU1…3 in a passive optical network PON specified in accordance with ITU-TG.983 is requested by the optical network monitoring unit OLT by means of PLOAM cells - Physical Layer Operation/Administration and Maintenance Cells. In response, the respective optical network termination units ONU1…3 transmit corresponding queue filling level information fs1…n, which represents the current queue filling levels, to the optical network monitoring unit OLT using specific minicells - which are also referred to as minislots.

The queue filling level information fs1…n for the queues WS1…n which are arranged in an optical network termination unit ONU1…3 are advantageously transmitted on an ATM service class specific basis, that is to say the sum of the filling levels - referred to as ifs_CBR, ifs_VBRrt, ifs_VBRnrt, ifs_GFR, ifs_UBR in Figure 2 - of ATM connections vCBR1…3, vVBRrt, vVBRnrt1…x, vGFR1…y, vUBR and of queues for each ATM service class CBR, VBRrt, VBRnrt, GFR, UBR is in each case formed in the respective optical network termination unit ONU1…3, and is transmitted to the optical network monitoring unit OLT. By way of example, as shown in Figure 2 for the ATM service class VBRnrt, the sum of the filling levels of the third to k-th queues WS3…k - in this case ifs_VBRnrt = Σ fs3…k - and the sum of the filling

levels of the 1-th to m-th queues WS1…m - in this case ifs_GFR = Σ fs1…m - is formed and is transmitted to the optical network monitoring unit OLT. In the case of queues - not illustrated in Figure 2 - which are set up for virtual connections VC, the sum of the filling levels of the respective queues associated with each virtual connection is advantageously transmitted.

A first, upper ATM service class specific queue total filling level limit value $x_{HIGH}1…s$ is provided, and is stored, for each associated ATM service class CBR, VBRrt, VBRnrt, GFR, UBR in the optical network monitoring unit OLT. ATM service class specific queue total filling level information ifs_CBR, ifs_VBRrt, ifs_VBRnrt, ifs_GFR, ifs_UBR, which is transmitted from the three optical network termination units ONU1…3 to the optical network monitoring unit OLT, is permanently compared with these stored, ATM service class specific queue total filling level limit values $x_{HIGH}1…s$. According to the invention, the access controller MAC which is arranged in the optical network monitoring unit OLT is designed such that the three optical network termination units ONU1…3 access the passive optical network PON

- as a function of the ATM service class of the respective ATM connections vCBR1…3, vVBRrt, vVBRnrt1…x, vGFR1…y, vUBR which are routed via the optical network termination units ONU1…3, and
- as a function of the comparison results of the transmitted, ATM service class specific queue filling level information ifs_CBR, ifs_VBRrt, ifs_VBRnrt, ifs_GFR, ifs_UBR with the stored queue total filling level limit values $x_{high}1…s$.

The following ATM traffic parameters are relevant for controlling the access to the passive optical network PON for the respective ATM service classes:

- the traffic parameter "Peak Cell Rate (PCR)" for ATM connections in the ATM service classes CBR and

VBRrt,

- the ATM traffic parameter "Sustainable Cell Rate (SCR)" for ATM connections in the ATM service class VBRnrt "Sustainable Cell Rate (SCR)", and
- the ATM traffic parameter "Minimum Cell Rate (MCR)" for ATM connections in the ATM service class GFR.

If the access control unit MAC which is arranged in the optical network monitoring unit OLT finds that one of the first upper ATM service class specific queue total filling level limit values $x_{HIGH}1...s$ which are stored in the optical network monitoring unit OLT has been exceeded for one of the connected optical network termination units ONU1...3, then the access control unit MAC once again increases the transmission resource element tpr1...3, which is allocated to a reduced extent in the relevant optical network termination unit ONU1...3, such that the minimum guaranteed transmission capacity is once again provided for the relevant ATM connections vCBR1...3, VBRrt, VBRnrt1...x, vGFR1...y, vUBR in the corresponding ATM service class CBR, VBRrt, VBRnrt, GFR, UBR. The transmission resource elements tpr1...3, which were allocated to an optical network termination unit ONU1...3 using the method according to the invention, in the passive optical network PON are in this case increased as a function of the respective ATM service class CBR, VBRrt, VBRnrt, GFR, UFR:

- for ATM connections in the ATM service class CBR - in this case the tolerant class - and in the ATM service class VBRrt, the allocated resource elements tpr1...3 are increased at least to the sum of the "Peak Cell Rate (PCR)" of all the CBR/VBRrt connections,
- for ATM connections in the ATM service class VBRrt, the allocated resource elements tpr1...3 are increased at least to the sum of the "Sustainable Cell Rate (SCR)" for all the VBRnrt connections, and
- for ATM connections in the ATM service class GFR,

the allocated resource elements tpr1…3 are increased at least to the sum of the "Minimum Cell Rate (MCR)" for all the GFR connections.

ATM connections in the stringent class - that is to say the ATM connections vCBR1…3 in the non-tolerant ATM service class CBR - are advantageously ignored in the described access control, since ATM connections vCBR1…3 such as these place stringent requirements on the guaranteed minimum transmission bandwidth and compliance with the guaranteed ATM traffic parameters and QoS parameters, which must not be undershot. A connection-specific calculation - also referred to as VC-specific - and allocation of the transmission resource elements tpr1…3 in the passive optical network PON are carried out for ATM connections such as these which are routed via an optical network termination unit ONU1…3 and which pose appropriately stringent requirements on the ATM-specific traffic parameters and QoS parameters, with at least the sum of the guaranteed minimum transmission capacities being reserved for such ATM connections vCBR1…3.

The respective absolute queue filling level fs1…n of the queues WS1…n pointing in the upstream direction is evaluated in a weighted manner by the control unit MAC which is arranged in the optical network monitoring unit OLT, for assignment of transmission resource elements tpr1…3, which are allocated to an optical network termination unit ONU1…3, beyond the guaranteed minimum transmission capacities of the ATM connections vCBR1…3, vVBRrt, vVBRnrt1…x, vGFR1…y, vUBR. The weighting factor for the individual ATM service classes CBR, VBR, VBRnrt, GFR, UBR can be configured as required in the optical network monitoring unit OLT.

As already described, the queues WS1…n which are arranged in an optical network termination unit are read in a weighted manner by means of the WFQ scheduler. According to the invention, the weighting factors for the queues WS1…n are matched to the

time-division-multiplex-oriented transmission resource elements tpr1…3 which are currently allocated to the optical network termination unit ONU1…3, that is to say they are reduced, in the passive optical network, and their sizes are defined such that the queues for ATM connections vVBRrt, vVBRnrt1…x, vGFR1…y, vUBR in the non-stringent classes are read with the minimum guaranteed transmission capacity below the [lacuna] in each case for the ATM connection. Each queue WS1…n which is arranged in an optical network termination unit ONU1…3 is advantageously allocated a second upper queue filling level limit value $y_{HIGH}1…s$. The first upper, ATM service class specific queue total filling level limit values $x_{HIGH}1…s$ which are stored in the optical network monitoring unit OLT, and the second connection-specific queue filling level limit values $y_{HIGH}1…s$, which are stored in the optical network termination units ONU1…3, have a fixed relationship with one another. The ratio of these queue limit values y_{HIGH}/x_{HIGH} depends on the frequency with which the queue filling levels fs1…n of the queues WS1…n pointing in the upstream direction are checked, and can be set to the value 1 if the checking frequency is greater than a specific level. If the control unit STG which is arranged in the optical network termination unit ONU1…3 finds that one of the two upper queue filling level limit values $y_{HIGH}1…s$ has been exceeded, then the control unit STG recalculates the weighting factors for the queues WS1…n. The recalculated weighting factors are used for reading the queues WS1…n for the purposes of the minimum transmission capacities guaranteed for the individual ATM connections.

By way of example, a situation can occur in which queue filling level information fs1…n or ATM service class specific queue total filling level information ifs_CBR, ifs_VBRrt, ifs_VBRnrt, ifs_GFR, ifs_UBR which has been corrupted by transmission errors is transmitted by the optical network termination units ONU1…3 to the optical network monitoring unit OLT. This can result in the rate at which the WFQ schedulers are read in the

optical network termination units ONU1…3 not matching the time-division-multiplex-oriented resource elements tpr1…3 which are allocated to each optical network termination unit ONU1…3 in the passive optical network PON so that, for example, the guaranteed minimum transmission capacities for those ATM connections in ATM service classes which have a lower priority classification are no longer complied with. In order to prevent possible data losses, the first upper ATM service class specific queue total filling level limit value x_{HIGH}1…s which is allocated to a queue WS1…n - and which controls the allocation of the transmission resource elements tpr1…3 in the passive optical network PON - is advantageously set to be lower than the associated second upper queue filling level limit value y_{HIGH}1…s - which controls the WFQ scheduler for an optical network termination unit ONU1…3, which makes it possible for the optical network monitoring unit to identify at an early stage that a queue WS1…n is overflowing. When transmission errors occur during transmission of queue filling level information to the optical network monitoring unit OLT, this prevents the optical network monitoring unit OLT from allocating an excessively small extent of transmission resource elements tpr1…3 in the passive optical network PON to the individual optical network termination units ONU1…3, hence making it temporarily impossible to comply with the guaranteed minimum transmission capacities for the ATM connections vCBR1…3, vVBRrt, vVBRnrt1…x, vGFR1…y, vUBR which are routed via an optical network termination unit ONU1…3.

According to another embodiment - not illustrated - an additional first lower ATM service class specific queue total filling level limit value and a second lower connection-specific queue filling level limit value are provided for each of the queues WS1…n which are arranged in an optical network termination unit ONU1…3, with the transmission resource element tpr1…3 which is allocated to each optical network termination unit ONU1…3 being reduced if the first lower ATM service

class specific queue total filling level limit value which is allocated to a queue WS1…n is undershot, and with the rate of reading of the WFQ scheduler being reduced if the second lower connection-specific queue filling level limit value is undershot - for example below the sum of the guaranteed minimum transmission capacities of all the ATM connections vCBR1…3, vVBRrt, vVBRnrt1…x, vGFR1…y, vUBR in each case in one ATM service class CBR, VBRrt, VBRnrt, GFR, UBR.

The generation and calculation of the upper and lower ATM service class specific queue total filling level limit values and connection-specific queue filling level limit values can be carried out in a first step by inputting via a network management interface, which is in each case arranged in the optical network termination units ONU1…3 or in the optical network monitoring unit OLT. Alternatively, in particular in the case of complex network configurations, these queue filling level limit values are calculated by an algorithm in the respective optical network termination units ONU1…3 or in the optical network monitoring unit OLT as a function of the ATM traffic parameters for the respective ATM connections vCBR1…3, vVBRrt, vVBRnrt1…x, vGFR1…y, vUBR.

The method according to the invention is suitable in particular for subscriber access networks ACCESS in which no signaling functionalities, or only a small number of signaling functionalities, are transmitted to the ATM layer. However, the method according to the invention can also be used for switched virtual connections, or SVC connections. In this situation, the current ATM traffic parameters for the respective ATM connections vCBR1…3, vVBRrt, vVBRnrt1…x, vGFR1…y, vUBR must be transmitted to the optical network termination units ONU1…3 and to the optical network monitoring unit OLT.

If the optical network monitoring unit OLT has an "ATM

switch" functionality, then the provision of the ATM traffic parameters for the access control unit MAC which is arranged in the optical network monitoring unit OLT must be controlled internally. If the optical network monitoring unit OLT is in the form of an autonomous network element without any SVC functionality, then the ATM traffic parameters can be provided from the higher-level ATM switch via a VB 5.2 interface. For the monitoring function, in which the passive optical network PON is checked for the presence of sufficient transmission capacity when setting up an ATM connection vCBR1…3, vVBRrt, vVBRnrt1…x, vGFR1…y, vUBR, the access control functionality described above is transparent; however, it is not permissible to overbook the minimum guaranteed transmission capacities for the ATM connections vCBR1…3, vVBRrt, vVBRnrt1…x, vGFR1…y, vUBR which are routed via the passive optical network PON.